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STATE OF CALIFORNIA
ENERGY RESOURCES AND CONSERVATION
AND DEVELOPMENT COMMISSION

Development of Statewide	)	Docket No. 06-OII-1
Guidelines Reducing Impacts	)	Developing Statewide Avian
From Wind Energy Development	)	Guidelines

Comments from the
Center for Energy Efficiency and Renewable Technologies
On Staff Workshop # 3

October 5, 2006

Introduction

CEERT would like to commend the effort being made by the CEC and CDFG staff to address comprehensively all issues raised in the development of wind energy in California. In the following comments we begin by discussing issues of greatest concern. Following these general comments we attempt to answer the agenda discussion questions. Admittedly there are some questions for which there is no clear answer. In future iterations of these guidelines new studies and findings will hopefully build our knowledge and allow us to answer the remaining questions. Finally, we have attached a document describing general parameters used for pre and post-construction monitoring programs of successfully permitted projects. These programs are offered as a suggested point of reference in the drafting process.

The following comments are guided by the goal of avoiding significant impacts to avian and bat populations while producing clean wind energy. We recognize that determining what constitutes significant population impacts is not an exact science, but we believe that this is a goal upon which all stakeholders can agree. The guidelines should also seek to thoroughly consider the range of wind energy benefits, including reduction of toxic and greenhouse gas emissions which contributes positively to the health of wildlife populations and the fight against global warming. Following the release of these guidelines, the development process of each project will still present issues for debate. These guidelines should provide thoughtful information for all stakeholders to have a consistent approach to the process and plan accordingly.

General Comments

A. "Green Allowances"

There is considerable value to wind energy beyond the electricity that it generates. Wind turbines do not produce any of the toxic or global warming pollutants that are created by even the cleanest fossil fuel power plants. As California gears up to combat global warming with the passage of AB 32, the climate emissions cap, and continuing work on the Renewable Portfolio Standard, new wind power is critically needed to offset the demand for new fossil

fuel generation and in the future, replace the dirtiest plants as they are decommissioned.

For its part, government has recognized the value of clean, renewable generation technologies, such as wind, by subsidizing their production. Federally this has taken the form of a production tax credit and in California wind can (but has yet to) receive ratepayer funding for cost determined to be above market. As with any emerging industry, this funding has been incredibly important to help wind establish itself as an energy source competitive with conventional fossil generation. However, this financial subsidy plays no role in assessing the environmental impact of a wind project during the permitting process. It is also important to remember that the fossil fuel industries of coal, oil and natural gas also receive substantial government subsidies.

Currently when a lead permitting agency is assessing the environmental impact of a wind project, only negative impacts are accounted for. Stakeholders supporting clean energy may voice support for the project on the grounds that it will keep new coal or gas generation from being built and fight global warming, but this cannot be formally considered by the permitting body. While difficult to measure, the impacts to bird species due to global warming are potentially catastrophic. Though it is not the “silver bullet”, wind energy will be an important part of the solution if a global warming disaster is to be averted.

Clearly wind energy thus also represents some benefit to avian and bat species. A logical and balanced permitting process should allow the permitting agency to weigh both the biological benefits as well as the detriments for a given project. Simply because we do not understand completely the nature or implications of global warming is not a reason to delay action in addressing the threat. Similarly, because we do not fully understand the benefits of wind power to biological populations does not mean these benefits cannot be given due consideration in a permitting process.

B. Mitigation Approaches

In the development of these guidelines many stakeholders have entered the discussion with an intimate knowledge of the problems and proposed solutions for the Altamont Wind Resource area. It is important to remember that this resource area pioneered the technology of wind turbines and site development. As with the development of any industry, mistakes were made. However, Alameda County has worked to create a process with key stakeholders to resolve outstanding problems. The development of this guidelines process recognizes that the situation in Altamont is unique, and the State guidelines process should not focus on resolving that conflict. Likewise, negotiations in the Altamont have produced several mitigation concepts which have been attempted in that area. Those concepts are extremely unlikely to work effectively in other areas and may pose practical problems in the Altamont as well.

Specifically, as projects are currently financed and revenue sources structured, the idea of seasonal shutdowns would make nearly all new wind

projects unviable and represents only the most extreme of circumstances. Similarly, any adaptive management program which involves the removal or repositioning of turbines would cause major financial hardship upon the project owner and would most likely warrant the project infeasible. Fortunately, study and siting techniques have been able to avoid recreating the anomalous circumstances seen in the Altamont. For the current set of guidelines it will be most important to focus on more moderate mitigation practices which address the smaller impacts of modern wind projects.

Coming out of the discussion and workshop in Bakersfield there were two basic approaches which are most palatable to the majority of stakeholders. The use of a mitigation banking system modeled on existing systems for wetlands or endangered species banks presents a solution that has been very effective for other industries trying to deal with habitat impacts. The purchase and preservation of avian habitat to offset any negative impacts from wind energy will offer benefits to avian and bat species. Though there is some question as to what level of benefits will be provided by this type of mitigation measure, it is a useful solution for project developers who can, early on, factor in the cost of such mitigation into the cost of a project. Additionally the general concept has been in use for a number of years already and would not need to be created from scratch. This type of mitigation could also serve as an interim solution until more effective forms have been vetted.

The idea of establishing a fund for experimental mitigation has also been proposed. One of the most difficult problems generally in trying to resolve the issues of wind energy's impacts on birds and bats has been a need to apply theoretical mitigation measures (e.g. Hodos blade-painting techniques) in the field. In many ways the industry has come a very long way: new study techniques have been able to rule out development of high risk sites, and the technology has greatly reduced the risk of collision for most species. However, the effectiveness of different mitigation measures is much less certain. Mitigation techniques such as Hodos blade painting, vegetation and/or prey management are only a few possibilities which deserve further field testing. Indeed, some of these mitigation techniques are referenced in the latest Grainger Hunt PIER-published paper on Golden Eagles. However, the cost of a comprehensive scientific study to apply a mitigation technique in the field with a Before After Control Impacts design, exceeds reasonable and feasible mitigation costs for a single project. By pooling their mitigation funding, developers could finance a comprehensive study of experimental mitigation which could eventually identify the most effective mitigation techniques. If these mitigation measures are instead implemented on a project by project basis, substantially more time could be spent determining the most effective mitigation techniques.

Ideally a program like this would be overseen by the CEC and mitigation study projects would be determined through a public process. Public funding would also be used to support the financing provided by project developers. Both PIER funding and the concepts upon which Natural Community Conservation

Plans are based reference these types of joint private-public funding. As all measures to mitigate the effects of wind energy on avian and bat species are still in experimental stages, financing a study of a mitigation method presents essentially the same benefit to these populations as arbitrarily implementing an experimental mitigation measure on a project by project basis. The pooled funding for these studies represents a lowest cost, streamlined solution to determining effective and ineffective mitigation measures.

C. Incentivize Low Risk Projects

Post-construction monitoring regimes should be encouraged by the guidelines when there is insufficient data from the site being developed or surrounding areas to presume insignificant population impacts from the project. Some level of post construction monitoring will likely be needed at most new wind projects in California. However, the guidelines should be sure not to create a disincentive for the development of low risk sites. On sites where mortality is low a *larger* sample and *greater* effort is needed to create a mortality estimate with the same confidence interval as a site with higher mortality.

It has been suggested that this disincentive might be off-set by mitigation costs. This is uncertain and mitigation could possibly be of lower cost than additional study. Such a disincentive would represent a major flaw in the structure of the guidelines. The key issue is what question is being asked. If pre-project analysis shows a site to have low risk, then the goal of post-construction monitoring should be simply to *confirm* low overall avian mortality. That requires a smaller sample size than to answer questions that involve even rarer events, such as trying to determine raptor or other avian sub-group mortality, differentiating mortality by location of turbines, or by turbine type.

We recommend that if pre-project studies suggest relatively low overall risk, then the post-construction monitoring should be for one year, and should only require a sample size adequate to determine, with a reasonable confidence interval, total avian and bat mortality. Only if the initial one year of monitoring shows unexpectedly high overall mortality should additional monitoring requiring potentially larger sample sizes be required. Higher risk sites would presumably begin with this more rigorous monitoring to obtain the larger sample.

It is important to remember that the biggest key to avoiding impact to avian and bat species will be in pre-construction monitoring. The guidelines should keep in mind that good pre-construction analysis should be rewarded. It will be in the interest of the developer to generate sound pre-construction estimates to avoid any unanticipated surprises later on in the project.

Agenda Discussion Questions

Day 1

1. When should a lead agency require compensatory mitigation? When should a lead agency require post-construction monitoring?

Laws governing the protection of avian species present a substantial challenge to wind energy developers. To the extent that they prohibit any "take" whatsoever, they do not allow for the careful application of accepted guidelines or reward low risk decisions. In determining when "compensatory" mitigation is required, the California Environmental Quality Act represents the most logical and comprehensive legal framework through which a wind developer can achieve legal compliance. It is to this existing statute that the CEC / CDFG guidelines should look most closely when suggesting compensatory mitigation and post-construction monitoring. In looking at required mitigation, however, agencies should carefully consider whether there really are accepted mitigation techniques. The alternative of an experimental mitigation fund referenced in B, above, would likely be a fairer and more efficient solution until we have developed the body of science that will allow for intelligent requirements of accepted and effective techniques that reduce mortality without eliminating wind energy (see Comment A, above).

The determination of compensatory mitigation measures cannot be overly prescribed in the guidelines, but must be looked at in the permitting process for each project. In the spirit of the laws protecting wildlife, the guidelines should seek to encourage compensatory mitigation measures when there is a reasonable belief, based on accepted science, that there will be significant impacts to a species population. For sites which do not cause impacts which represent a risk to avian and bat populations, no mitigation measures should be required. This finding should, in most cases, be based on pre-construction studies and verified by post-construction monitoring.

Exceptions from post-construction monitoring requirements may be made where there is sufficient pre and post-construction data from surrounding sites which can reasonably be used to assess impacts on a new adjacent site. As the guidelines continue to be followed in practice, many new and existing wind resource areas will grow over adjacent land. In instances in which valid pre and post-construction data for surrounding sites has determined impacts to be clearly less than significant, the guidelines should allow for a situation in which a site could be permitted with only preliminary biological assessment and without seasonal diurnal studies. In the preliminary biological assessment the project proponent should take care to ensure that the new site is in fact comparable. Issues which should be considered include topography, vegetation, water sources, nesting structures and any other characteristics which could greatly impact bird usage.

In sites which are determined to have a significant impact the agreed mitigation should relate directly to the level of that significance. Again, the guidelines cannot be overly prescriptive in this process, but should allow for each project's significance to be assessed on the merits of that project. Determination of mitigation practices cannot be a one size fits all process but will be agreed to by the permitting agency and the project proponent and possibly other stakeholders.

2. What is the appropriate role for CDFG and FWS to assist lead agencies in determining if data from other studies are applicable and adequate for developing impact assessments and mitigation measures?

Both CDFG and FWS have a higher level of expertise than most local lead permitting agencies in assessing biological impacts from development projects. These local permitting authorities, counties in most cases, should be able to depend on the regional CDFG and FWS staff to ensure that the permit documentation meets with all state and federal wildlife laws to the extent feasible. As such, with input from CDFG and FWS, compliance with these guidelines should offer assurance that the project proponents and permitting agencies are in compliance with all laws pertaining to avian and bat species. Formal statements from FWS and CDFG supporting the guidelines document would be an important sign to wind developers that the guidelines do offer some legal protection.

3. What criteria should be established for using pre-existing information for impact determinations, including deciding if a categorical exemption is appropriate?

Pre-existing information can be valuable, if applicable, in making impact determinations, by assisting in establishing the environmental setting for the project and the probability that impacts will occur. In cases where the information indicates that there is not a fair argument that adverse impacts will occur, a categorical exemption would be appropriate under CEQA. The extremely low risk that would lead to such an exemption would counsel a much lesser risk of violating any other avian protection statutes.

4. How much discussion should the guidelines include about impacts due to habitat loss?

Habitat loss is a question which is already sufficiently addressed through accepted practices of wind development and there are generally accepted mitigation practices for this. However, future research projects may seek to consider what impact loss to surrounding habitat through residential and other development plays in mortality at wind farms. Wind projects cannot be held fully accountable for mortality increases caused by loss of surrounding habitat.

5. How do the displacement and disturbance impacts due to wind energy development in California compare to other states and countries?

The lack of standard protocols for pre-construction studies or post construction monitoring has so far limited the ability for various sites in other states to be compared. These guidelines, if accepted elsewhere, will go a long way to increasing site comparability. However with work through the NWCC and other regional guidelines, this standardization has improved and is very likely to be useful in developing sites in California. Work in Eastern Oregon and Washington may be particularly valuable.

Additionally, larger research projects looking at meta-populations across California and regionally would be tremendously valuable. To the extent habitats and other conditions are similar these studies should be relied upon for comparison.

6. What are the necessary steps to develop a cumulative impact analysis and what should the scope of that analysis be?

A cumulative impact analysis should be developed where the project at issue is being evaluated. For purposes of these guidelines, one would look at the cumulative impact of this wind project and other wind projects currently in the permitting pipeline to assess whether cumulatively these projects pose an adverse impact to an avian species under CEQA. With careful pre-construction analysis of each project, and caution not to disturb habitat in the acreage around the turbines, cumulative impact analysis should not result in different outcomes than a careful project by project analysis.

7. How much detail should the guidelines provide on risk assessment protocol?

To the extent that detailed protocols are available the guidelines should seek to provide them. However, latitude should be given between sites with the understanding that different projects will have different pre-construction monitoring programs. Often the assessment of risk to a species or several species will depend on regional or local information that is routinely considered by a specialist but is not susceptible to generalization beyond that which is used in other biological assessments.

8. What kind of data from other studies could be included in the guidelines to assist in evaluating potential impacts?

All existing data can be of some value in developing a wind site and all should be considered acceptable in helping to evaluate potential impacts. The guidelines should offer some guidance on what kind of data is most credible and valuable and what kinds of data may be less useful. Ideally a new site would be able to use a study from a surrounding site to inform the impact assessment and site design. The guideline's standard study protocols should be highlighted as the most valuable information in comparing and assessing other sites. Other types of data may still be of value but will need to be assessed on a project by project basis. Examples of studies or data which would be useful include meta-studies of

population and radar monitoring documenting avoidance behavior. The value of all data will ultimately be evaluated by the permitting agency and regulatory agencies which are supporting them.

9. How much analysis should pre-permitting studies include on potential risk to populations due to wind energy development?

As population risk and cumulative impacts are the greatest concern we are trying to address in these guidelines, the analysis of pre-permitting studies should, to the extent possible, be put in the context of population risk. We acknowledge that this is a difficult task and the ability to properly assess these kinds of impacts will improve over time. However, it is important to make the effort. The accuracy of these analyses will vary depending on the existing knowledge of bird and bat population in the area around the development and the extent to which usage is attributable to migratory species. Additional research projects to better understand California's bird and bat populations will greatly improve this important population risk assessment. Additional information is provided in the "Study Protocols" attachment.

10. How should Ecological Risk Assessment be used to evaluate potential impacts to bird and bat populations?

A better understanding of the meaning of Ecological Risk Assessment would be necessary to respond to this question.

11. What type of ongoing forum would be useful to receive comments / suggestions to improve survey protocols and mitigation recommendation?

It would be helpful to have workshops at the CEC on a yearly basis to share ideas and experiences among agency staff, developers and other stakeholders. These work shops would offer those who use the guidelines a chance to share problems they may have experienced and also possible solutions within the existing guidelines structure. As in the initial iteration of any government guidance document, problems will inevitably arise and there will be a period of adjustment during which all stakeholders learn how best to use the guidelines. Three to five years should be allowed for this initial adjustment period before any attempt is made to amend or revise the guidelines. Over a longer period of time, while problems will arise in the way the guidelines have been drafted, it is also likely that people will gain a solid understanding of these problems and how they can be best be resolved.

12. How should knowledge advances from PIER research be incorporated into revised guidelines?

Without knowing what kind of knowledge advancements are made by PIER research, it cannot be known how research knowledge may be incorporated. Clearly the two processes, PIER and Wind/Avian Guidelines, must be closely linked as they have been so far. There is a feedback loop between the

two processes. The yearly meetings/workshops to discuss the success and shortcomings of the guidelines will likely advise PIER's work and the work of PIER will undoubtedly be a crucial part of the guideline's revision. The initial iteration of the guidelines should expect and allow for improvements in understanding and use of risk assessment and mitigation practices with in their framework.

Day 2

1. What evidence do we have that the new, larger turbines reduce collision impacts to raptors compared to old turbines? To resident / migratory songbirds? To resident / migratory bats?

The most comprehensive re-power study to date at Diablo Winds in the Altamont Pass showed substantial reduction in avian mortality across almost all species. While overall mortality was, as expected, greatly reduced, there was a large increase in mortality levels for Red Tailed Hawks. The nature of this increase is not well understood and is still being studied, but may be related to cyclical abundance of the Red Tailed Hawk population. This will not be a typical situation as the number of repower possibilities from the "egg beater" style turbine to the modern turbine is limited. In addition, the 2-year post-construction monitoring results from High Winds (Solano County) show that while raptor use there is high (second highest in the state after Altamont), raptor mortality is very much lower—suggesting that the newer wind turbine technology reduces mortality.

At the workshop in Bakersfield, Bob Tresher of NREL offered a logical equation for predicting the collision risk associated with wind turbines. Using this equation, the collision risk associated with wind turbines is directly related to the RPMs of a turbine. As the technology has progressively lowered the RPMs for state-of-the art turbines, according to Dr. Thresher's model, collision risk has also decreased. This theory has yet to be fully tested in the field but is an important illustration of the impact technological improvements can have on reducing avian and bat mortality.

2. What elements of turbine design / siting can be changed during the pre-permitting phase of development to reduce predicted impacts to birds and bats?

If micro siting techniques are feasible, then they should be implemented (see #3 below).

3. Are there examples where information about site characteristics influenced turbine design?

In this instance, Foote Creek Rim, WY, is the best example of adjusting site design to successfully address avian concerns. Sites are now regularly analyzed to try to determine patterns of bird use which could inform site design.

Very often no such pattern can be found. The topography and raptor usage at Foote Creek Rim makes it a good example of the benefits of modern siting techniques. At several sites in Washington and Oregon similar efforts were also made (e.g., Big Horn Wind Project and Leaning Juniper Wind Project). At these sites turbines were moved back from canyon rims to reduce impacts to raptors using those features.

4. What kinds of Best Management Practices, general guideline on turbine siting/design, and other generic avoidance measures have been useful on past projects and should be included in the guidelines?

Generally wind developers proactively search out the best site design and other avoidance measures to minimize avian and bat impacts to the extent possible. Developers who follow the guidelines generally should be assumed to be following best management practices. One additional point of guidance could be the training of all operations and maintenance personnel to observe and record all incidents of mortality during normal operations duties on the site once formal mortality monitoring has concluded. This type of continued incidental monitoring scheme would help to address concerns of long term variation in avian and bat activity and help to capture anomalous mortality events. Findings from this kind of monitoring would be made available to state agencies.

5. How can lead agencies establish an effective mechanism for implementing post-construction mitigation?

If the establishment of an Experimental Mitigation Fund were accepted, as discussed in Comment B, above, participating lead agencies could address post-construction mitigation in a manner that maximized effective experimental mitigation design and the overall achievement of effective mitigation techniques to be applied at sites with specific characteristics in the future. The Fund would then be an ongoing source of mitigation funding in the future.

6. Are there examples of successful implementation of seasonal shutdowns or other operational mitigation in reducing collision fatalities?

These types of mitigation measures have only been implemented experimentally in extreme circumstances. Their effectiveness is still being investigated. Please also refer back to comment B.

7. How can mitigation options be structured to provide (a) some certainty for mitigation implementation and (b) some certainty for financial risk for wind developers?

Generally the guidelines should be structured to reward a developer who properly and accurately assesses risk during a pre-construction study. As stated in earlier comments, the best way to minimize the impacts from wind energy is to conduct adequate pre-construction studies. Completely eliminating the uncertainty for mitigation implementation by putting a limit around it takes away a

developer's incentive to conduct comprehensive pre-construction studies. Importantly, the answer to this question not only addresses how to limit financial risk from mitigation but also post-construction studies which can also have significant financial impacts to a project.

A developer's post-construction study requirements or mitigation measures should be limited contingent upon the project's observed mortality levels falling within a given range of pre-construction estimates. If the project's observed mortality levels fall outside of that range a developer's level of study or mitigation may increase beyond the predetermined limit. This mortality range should not be based strictly on numbers, but on orders of magnitude and potential population impacts. For example a site expecting very low numbers of collisions could have mortality numbers which have substantial proportional variation but do not constitute significant population impacts. A site could have 10 mortalities one year and 20 the next, doubling the rate of mortality but still well below what would normally be considered significant (or even not an increase in mortality at all compared to available populations) and would not require any mitigation or further study. On the other hand, if a project's avian mortality disproportionately affected a sensitive species, there might need to be mitigation targeted at that species. Thus the range within which a project's preconstruction estimates should be considered valid (and limit financial risk), must be based on orders of magnitude and a level of impacts that would be considered significant to populations, not the precision with which mortality was predicted. In order to provide for project financial planning, it is important that the range of possible mitigation measures be identified in the project's permit, and that this range be feasible and financially reasonable.

To ensure that mitigation measures are successfully implemented will be the responsibility of the permitting and regulatory agencies. It has been raised during the guidelines process that CDFG has staffing shortfalls which make oversight of mitigation measures a difficult task. CEERT along with other process stakeholder would like to work with the CDFG to try to resolve this problem in the future.

8. How much detail should the guidelines include on mitigation options?

The guidelines should suggest scientifically-proven mitigation options which have been effective on past projects or may be applicable to new wind projects in California. The guidelines should not include mitigation formulas based on theory. The guidelines should provide as much detail as necessary to convey how the mitigation might be applied. However, it should be made clear that the list is not exhaustive. In each instance where mitigation measures are applied, the level of mitigation will be negotiated between the project proponent and the permitting agency. The guidelines cannot be overly prescriptive in that negotiating process and should allow project proponents and permitting agencies the opportunity to problem-solve. If scientifically-proven mitigation options cannot be identified, experimental options should be identified as such, with

considerable latitude for agencies and project proponents to determine how best to attempt useful mitigation.

9. How can guidelines provide guidance on determining the nexus between impacts and compensatory mitigation and the amount of mitigation?

The nexus between impacts and compensatory mitigation is poorly understood. The relationship will need to be determined on a project by project basis negotiated between the permitting agency and the project proponent. However, the guidelines should do their best to ensure that this decision is made based on best available science and understanding and not chosen arbitrarily out of a lack of knowledge. All too often we see prescriptions that substitute elimination of wind power for true mitigation. Mitigation must mean alleviation of impacts, not elimination of a project.

10. Would compensatory mitigation programs for wind energy be established on a county/regional/statewide level? How would such programs be administered?

A number of different methods have been proposed for mitigation programs. The structure of the program would likely depend on its nature. A research fund which finances the study of mitigation methods would most logically operate on a statewide basis through an existing agency. The PIER program and the CEC are the most obvious venue for this.

For habitat mitigation banks, these would more effectively operate on a county or regional scale. Often times these banks are set up as a private enterprise and certified by the permitting and regulatory agencies. This certification could be problematic because of the vast ranges used by many bird species.

See also comment B above.

11. When is it acceptable for compensatory mitigation to include an option for contributing to a research fund?

Please refer to comment B above.

12. What compensatory mitigation models (wetland or endangered species mitigation banks) would be appropriate for wind energy mitigation?

Please refer to comment B above.

PRE CONSTRUCTION MONITORING PROGRAM

Period:	Varies based on location
Frequency:	Varies based on location
Area to Study:	Points located across the potential project area
Data to Collect:	Bird use: 20-30 minute point counts at points identified in the area to study (note: point counts are identifying species within viewshed of the field biologist)
Time of Day:	dawn and dusk for small species and night migrants and mid-day for raptors
Analysis to Present:	Bird use in rotor swept area, fatality rates per MW and fatality rates per MW per year. Bird use should be subdivided to the following groups 1) all birds, 2) small birds, 3) large birds, 4) raptors, 5) grassland birds, 6) nocturnal migrants, 7) state endangered species and 8) bats.

POST CONSTRUCTION MONITORING PROGRAM

Period to Study:	Varies
Frequency:	once or twice per month during peak seasons (e.g. June and July limited to no studies)
% of Turbines:	25-100%
Searcher Efficiency Trials:	Yes (ranges from 40-50% for small birds and 70-80% for large birds)
Carcass Removal Trials:	Yes (note: this is the time it takes for a scavenger to remove a carcass)
Search Plots:	distance from turbine is the same as the turbine height at blade tip with a minimum plot of 180 x 180 m
Transects:	6 to 12 meters apart, adjusted according to habitat
Rate:	45-60 m per minute (speed adjusted based on habitat type)
Type of Fatality:	appeared to be related to the turbine – note: all fatalities are recorded
Commence Search:	when all turbines are operational
Condition of Carcass:	intact, scavenged, or feather spot
Carcass Storage:	carcasses are labeled, bagged and frozen
Carcass Recording:	Species, Sex and Age (when possible), date and time collected, location, condition, and any comments that may indicate the cause of death – photographed as found.
Formula:	The estimated annual fatality rate, m_1, is calculated as:

$$m_1 = \frac{\bar{c}}{\hat{\pi}_1},$$

where

$$\hat{\pi}_1 = \begin{cases} \frac{\bar{t} \cdot p}{I} & \text{if } I > \bar{t} \\ p & \text{if } I \leq \bar{t} \end{cases}$$

$\bar{c}$ represents the average number of carcasses observed p is the estimated searcher efficiency rate, $\bar{t}$ is the estimated carcass removal time, and I is the average interval between searches

Non-formal search carcass treatment: documented using a wildlife incidental reporting system or if a non-study personnel discovered the carcass, a biologist is contacted

Search Permits: Obtained from USFWS and state fish and game offices

Confidence: use 90% interval

Background Mortality: To be determined. In the past studies have assumed no background mortality in order to be conservative. This should be studied and a reasonable rate should be assumed for certain species.

Mortality Rates: estimated based on actual fatalities and results of the experimental trials